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Wikipedia Show-Offs: IQ Signaling in Online Information Pools

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by

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ABSTRACT

Wikipedia Show-Offs: IQ Signaling in Online Information Pools

Christian Yoder

Online information pools such as Wikipedia, Youtube, and Reddit, rely on contributions from members to succeed. These venues operate as public goods, being non-excludable and non-rival, and they typically do not compensate contributors. As such, contributions appear to be altruistic, and the enterprise subject to collective action problems, such as free riding. Despite this, the internet is replete with examples of successful information pools. A potential but un-tested explanation for altruism in this context is found in costly signaling theory. Costly signaling theory assumes that altruism is apparent rather than real; signals are in fact genetically self-interested acts that are compensated by receivers. If costly signaling theory is correct, contributions to online information pools must contain signals of some kind, signaling should be more intense under conditions where signalers are potentially rewarded by receivers, and receivers should be able to reliably infer signal content from contributions. This thesis tested whether contributions to ostensible wiki-style encyclopedias signal intelligence, group commitment, introversion-extraversion, or conscientiousness. To induce motivation, participants made their wiki-style contributions under conditions where they believed themselves to be either identifiable to receivers (i.e., and motivated to signal) or not. Contribution quality increased with participant intelligence, and, consistent with costly signaling theory, this was true only when participants believed they were identifiable to receivers. Further, receivers reliably inferred contributor intelligence from judgments of contribution quality, but only in when participants were identifiable. There was no evidence for signaling of other qualities. The findings suggest that contributions to online information pools are not examples of altruism, but are in fact signals

of intelligence that are reliably inferred by receivers from contribution quality. Recommendations for future research and practical implications are discussed.

Wikipedia Show-Offs: IQ Signaling in Online Information Pools

A hallmark of the web is its ability to facilitate the creation of massive repositories of media content that are predominantly created by non-experts. Websites such as Wikipedia, Reddit, and YouTube, for example, rely on the contributions of millions of disaggregated non-expert users. These media, which are venues for consumption as well as participation, have been referred to as information pools (Cheshire & Antin, 2008). Because these sites typically do not provide tangible compensation for contributions, and because users are not required to contribute, contributions appear to be altruistic and the system vulnerable to free riding. Thus, research has been focused on understanding why users contribute to online information pools.

Researchers have investigated the effects of various motivations (e.g. Lakhani & Wolf, 2003; Oreg & Nov, 2008; Nov, 2007; Nov, Naaman, Ye, 2010; Roberts, Hann, & Slaughter, 2006; Cho, Chen, Chung, 2010), and website design features (e.g. Nov, Naaman, & Ye, 2010; Cheshire & Antin, 2008) on contributions. However, relying exclusively on proximal explanations, this work does not address *why* people would be altruistic when the temptation to free-ride is patently strong. From an evolutionary perspective, altruism is a challenging puzzle. Evolutionary biology has produced an array of theories that explain altruism, but they have not yet been applied to explaining contributions to online information pools. While several evolutionary theories of altruism can potentially explain contributions to online information pools, costly signaling theory provides a strong prima facie case; as such it is the focus of this thesis (Grafen, 1990; Zahavi, 1995). A better understanding of what motivates people to contribute to information pools could also provide practical guidance for

managing online information contributions.

In what follows, I review current research on online contributions and consider several evolutionary accounts of altruism, with a focus on costly signaling theory. The proximate and evolutionary research is used to develop three hypotheses about signal content, which are tested in an experiment.

Proximal Motivations for Contributions to Online Information Pools

Research on contributions to online information pools has focused on proximal motivations for contributions and web site design features.

Desire for status. Research suggests that people are consciously aware of a number of motivations for contributions to open-source software communities. One potential motivator for contributing to an online information pool is a desire for status. Roberts, Hann, and Slaughter (2006) conducted a longitudinal survey of nearly 300 open-source software contributors and found that the desire for status was highly predictive of contribution amounts.

Intrinsic motivations. While extrinsic motivations such as a desire for status are a potential factor motivating contributions, intrinsic motivations may also play a part. Lakhani and Wolf (2005) surveyed nearly 700 software developers and found that self-reports of the ability to express creativity was their primary motivation for participating in open-source software projects. Similarly, Oreg and Nov (2008) found that contributions to open-source software were associated with reputation building and self-development, while contributions to Wikipedia were associated with altruistic motives as assessed by a 3-item self-report scale. In a separate study, a survey of Wikipedia contributors found that altruistic motives were

predictive of self-reports of intent to contribute to Wikipedia (Cho, Chen, & Chung, 2010)

Social identification. Identifying with the recipients of contributions may also play a role in contributors' motivations to create content. Nov, Naaman and Ye (2010), for example, found that respondents commitment to the online community Flickr was positively associated with the number of photos they uploaded. Similarly, Flanagin, Hocevar, and Samatiho (2013) found that college students were more motivated to contribute to a fictitious website resembling 'Rate My Professor' when they were led to believe that the recipients of the contributions were similar to them.

Design decisions can also affect rates of contributions, presumably because these features affect or induce motivations in contributors. For example, Cheshire and Antin (2008) tested a variety of feedback messages on voluntary crowd-sourced tasks on the website Mycroft. They found that contributors produced more content when they were thanked, shown a list of their past contributions, and ranked by contribution frequency in relation to other users (i.e., implying that status may have been a motivating factor). Similarly, Rashid et al. (2006) found that users of a movie-rating database were more likely to contribute ratings to audiences with similar rather than dissimilar genre preferences (i.e., suggesting a role for identification with similar others). Contributors also produced more ratings when they believed that their audience more highly valued their ratings (i.e., suggesting status motives).

Situational Effects on Contributions to Public Goods

Free riding refers to situations in which it is possible to benefit from a good without incurring costs. For example, a publicly-funded radio station is vulnerable to free riding because listeners may choose not to contribute. Likewise, Wikipedia offers another example

of a good that is vulnerable to free riding: People can read entries on Wikipedia without contributing themselves.

Free riding has been labeled ‘social loafing’ by social psychologists (e.g., Latané, Williams, & Harkins, 1979), and occasionally studied in the online context. Much research has been conducted on the factors that exacerbate and alleviate social loafing. For example, one factor that has been shown to reduce social loafing in collaborative tasks is identifiability. Williams, Harkins, and Latané (1981) demonstrated that participants shout less loudly in groups than individually. However, when participants were led to believe that their shouts were identifiable to others their shouts were as loud as participants who shouted alone. Williams et al. speculated that identifiability decreases social loafing because it increases the fear of negative evaluation.

Factors that contribute to or alleviate social loafing have been explored in online environments using the collective effort model (Karau & Williams, 1993). For example, Ling and colleagues (2005) discovered that people contributed more to collaborative tasks when they perceived their contributions were important to the group. While not explicitly invoking the collective effort model, Kimmerle and Cress (2008) explored contribution outcomes in an online information pool through an experiment with identifiable and non-identifiable conditions. Consistent with the literature on social loafing, the authors found that participants contributed more to a shared database when contributors could see each other’s contributions than when they could not.

Evolution and Altruism

While the proximal research shows that contributions to public goods are most likely

to take place under conditions of identifiability, and that there are likely to be motivational reasons for those contributions, a number of questions remain. In particular, the explanations offered for group behavior are all proximal accounts of motivations From an evolutionary perceptive, contributions to public goods without compensation (i.e., altruism) is not to be expected and requires special explanation. A fuller explanation is needed that elucidates not just the proximal mechanisms that explain *how* motivations link to behaviors, but also the deeper functional significance of these motivations. In fact, biologists have developed a number of ingenious theories to explain apparent altruism, none of which have been applied to explaining contributions to online public goods. As such, this thesis follows calls within the field to adopt biological approaches to understanding human communication (Cappella, 1996; Weber, Sherry, & Mathiak, 2008).

From a gene-centric perspective (Hamilton, 1964; Williams, 1966; Dawkins, 1976), altruism is puzzling. Given that genes are the unit of selection, it follows that organisms that provide fitness benefits to other organisms would, over time, disappear from the gene pool. How could a gene evolve that causes an organism to provide benefits to another organism without any apparent benefit? This starting proposition has led to several proposed solutions to explaining away apparent altruism. In each case, the explanation rests upon finding ways in which the seemingly altruistic behavior is actually selfish, and provides net benefits to the altruist. The major theories include kin selection (Hamilton, 1964), reciprocal altruism (Trivers, 1971), and costly signaling theory (Zahavi, 1975)[1].

[1] It is worthwhile to briefly consider the orthodoxy that the selfish gene approach replaced; namely, group selection (Wynne-Edwards, 1962). The theory assumes that organisms are selected and evolve at the level of

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Kin selection (Hamilton 1964) theory was the first to provide a gene-centric explanation for the emergence of altruism. Kin selection theory assumes that genes are the unit of selection, and that "altruism" can exist if net benefits are given to others who share genes for altruism. The frequency of altruistic genes can increase in a population, even if individuals suffer costs, so long as the genes shared among individuals receive net benefits. Kin selection theory assumes that genes for reciprocity are likely to be shared among people who have a relatively close genetic association—i.e., kin. While kin selection theory has provided a strong explanation for the emergence of altruism, it is not clear how the theory would apply in the context of the internet, a globally distributed, decentralized virtual environment where users are more often than not unrelated. The model requires that people can reliably infer the likelihood that they are interacting with kin, or that they can estimate this using (evolved) heuristics. In either case, interactions with people with palpably different ethno-linguistic heritages should obviate the kin selection process. If the kin selection process is operative in the online environment, it is likely that it only occurs in the context of strong ingroup relationships.

A second gene-centric model, put forth by Trivers (1971), assumes that altruism can

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groups, and that groups with individuals who behave altruistically are more apt to survive and reproduce than groups whose members behave selfishly. While intuitively plausible, this model requires that two strict but rare conditions are met: Genes must not be transferred among groups for evolutionary stability to emerge, and groups that are less altruistic would also have to have much lower levels of fitness (Williams, 1966). Both conditions are unlikely to be met in human groups where gene flow is high, and compromised group fitness is rare. Further still, pure group selection models do not meet the conditions for evolutionary stability. Namely, groups in which individuals follow a purely altruistic strategy are vulnerable to social parasitism, which would be strongly selected. A group of altruists would confer fitness benefits on selfish individuals, thereby replacing altruism as a strategy (Maynard Smith, 1964). While group selection continues to have proponents in the form multi-level selection models (e.g., Wilson, 2005), the theory has rarely attracted empirical attention. Parsimony and empirical evidence weighs heavily in favor of the selfish gene theory (see Dawkins, 1976).

evolve when acts of generosity are reciprocated in the future. For example, an altruist with a surplus who provided food to another person would receive a net benefit in the long run if the favor is returned in the future when he or she had a surfeit of food. Further, the model can be shown to be evolutionarily stable as cheating is curtailed if "cheating has later adverse effects on [the cheater's] life which outweigh the benefits of not reciprocating" (Trivers, 1971, p. 36). While this model may apply in some cases of online information sharing, it is likely that the model does not typically apply because there is often no mechanism for ensuring reciprocity or effectively policing cheats.

Costly signaling theory is the third gene-centric model. Costly signaling theory assumes that altruistic behaviors are social signals that benefit signalers and receivers. Formally, a signal is "an act or structure that alters the behavior of another organism, which evolved because of that effect, and which is effective because the receiver's response has also evolved" (Maynard Smith & Harper, 1995, p. 15). According to costly signaling theory, signals alter the behavior of other organisms because they provide information about traits possessed by the signaler. For example, the peacock's tail (their size, symmetry, and configuration) signals genetic quality to females, which is useful in mate selection (Zahavi, 1975). The signal is beneficial to the male because it enables him to attract mates, and it is beneficial to the female because she can choose the best quality male.

The key insight of costly signaling theory is that it explains how signals can be honest, despite the strong incentive to cheat (i.e., provide the phenotypic expression of the signal without possessing the signaled trait). Cheating is decreased to a tolerably low level because signalers of higher quality are able to afford to signal more intensely than lower

quality individuals. As signal intensity increases, the costs to the individual are proportionately greater, but so too are the benefits. Thus, highly intense signals are worthwhile to individuals who possess the quality in question (i.e., they are rewarded with fitness benefits), but individuals who do not possess the quality in question find the costs prohibitive. Through this cost/benefit mechanism, signal intensity tracks signaler qualities. These qualities are signaled honestly to receivers (on average), and thus evolutionary stability is achieved—in this case, an evolved communication system. To continue with Zahavi's example, the bigger and brighter the peacock's tail (i.e. the more intense the signal), the greater the costs paid. Bigger tails are more metabolically costly, and large bright plumage will make it more difficult to evade predators. Thus, a peacock that possesses a large and bright tail must also possess commensurate phenotypic qualities such as strength, speed, or pathogen resistance that allows him to survive despite these handicaps. At the same time, males who lack these qualities would find the costs prohibitive, because they are likely to suffer disease or predation. Thus, the peacock's tail *reliably* signals underlying quality, female preferences for males with larger tails evolves, and cheating is reduced to a level that is tolerably low to receivers.

Costly Signaling and Signal Content in Altruistic Acts

If costly signaling theory is correct, then putatively altruistic behavior must be a form of social signaling in which a hidden quality about signalers is communicated to receivers for genetically selfish reasons. Research has been largely focused on discovering what these hidden qualities might be, and/or the benefits for altruists.

Intelligence. Millet and Dewitte (2007) have argued that altruistic behavior signals

general intelligence. Because intelligent people are better able to acquire resources, their generosity is less costly (even if they have yet to acquire those resources)—a key condition in costly signaling theory (see Grafen, 1990). They support their claim through a study involving a modified social dilemma game that allowed a distinction between "cooperative behavior" and "altruistic behavior." As in the aforementioned study, participants could choose how much they wanted to contribute to a public good, a behavior that is personally costly but beneficial to the larger group. Participants were then categorized as altruistic, cooperative, or selfish depending on their contribution amounts. The researchers then measured participants' intelligence and found that altruists scored higher on an IQ test than both cooperative and selfish participants.

But why might someone wish to signal intelligence in the first place? Recent evidence suggests that intelligence is linked to general fitness. For example, Deary and Der (2005) found greater longevity among people with higher intelligence, even after controlling for a variety of socioeconomic factors. Miller (2000) has proposed a "general fitness factor" that influences everything about an individual's ability to survive and reproduce, and that mental health, sexual attractiveness, physical strength, and intelligence are all indicators of this underlying fitness factor. Indeed, there are positive associations between general intelligence and body symmetry (Prokosch, Yeo, & Miller, 2005), and semen quality (Pierce, Miller, Arden, & Gottfredson, 2009), and a negative association between intelligence and medical abnormalities (Arden, Gottfredson, Miller, 2009). These observations suggest that intelligence may be signaled: Those of higher intelligence possess higher general fitness; generosity is less costly for people of higher intelligence; receivers can benefit from

relationships with higher rather than lower intelligence people; and higher intelligence people can benefit from signaling—they can attract mates, deter rivals, or forge coalitional relationships.

Group commitment. Sosis (2003, 2006) has used costly signaling theory to explain costly religious rituals and costly tribal practices including ritual scarification, tattooing, and genital mutilation. Sosis (2006) hypothesized that these costly rituals act as a signal of ingroup commitment in groups that are characteristically involved in warfare. The signal of commitment would decrease the rate of freeriding, which is at a premium when the chances of death in combat are high. The costliness of such signals ensures their reliability, as "only those who are committed to the group's beliefs and goals will be willing to incur the time, energetic, and opportunity costs of ritual performance" (p. 235).

Sexually-selected traits. Griskevicius, Tybur, Sundie, Cialdini, Miller, & Kenrick (2007), argued that altruistic behaviors serve as advertisements of desirable qualities in mates, such as the ability to provide parental investment. For example, Griskevicius et al. found that people are more willing to engage in benevolent acts when they are conspicuous (i.e. presented to a large audience), especially after a sexual prime. However, the willingness to engage in seemingly "benevolent" acts depended both on the sex of the participant and specific acts. For example, men were more likely to report wishing to engage in acts of heroism and bravery (e.g., saving strangers from a bear), while women were more like to report conspicuous helping (e.g., volunteering at a homeless shelter). Further support for altruism as a mating device is found in evidence demonstrating that altruists are more desirable for long-term relationships than their "neutral" counterparts (Barclay, 2010).

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Physical strength and ability. Smith and Bliege Bird (2000) have hypothesized that altruistic behaviors can honestly signal strength, agility, and other physical abilities. The researchers provide a case study in which people living on an island in the Torres Strait engage in the physically taxing, difficult, and dangerous activity of turtle hunting only to gift the turtle meat to neighboring villages. While the activity does not appear to benefit the hunters themselves, Smith and Bliege Bird argue that such an act offers a reliable signal of physical ability that is then compensated through the conferral of status, the intimidation of rivals, and the attraction of coalition partners.

Status signaling. Finally, researchers have argued that people perform altruistic acts in order to accrue status. Although not signal content in and of itself, the benefit of heightened status might explain why people behave altruistically. Hardy and van Vugt (2006) suggested that altruists are rewarded with status and prestige by their communities, which in turn benefit receivers with the altruist's continued presence. As a result, altruists seek to outcompete each other's generosity. Hardy and van Vugt confirmed their "competitive altruism" hypothesis through an experiment involving a public good dilemma. In this experiment, participants were given a small starting pool of money. They could either contribute to a private fund, which they would each keep in its entirety, or they could put the money into a public fund where it was multiplied and split among the group. The incentive structure ensured that each individual was financially better off by contributing to his or her own fund, but worse off than if all participants contributed to the group fund. Hardy and van Vugt found that while altruists earned significantly less than selfish participants, they also received a significantly higher status rating and were more likely to be selected as the group

leader. Further, this effect was only confirmed in an experimental condition where reputation was tracked.

In sum, research suggests that altruism signals group commitment, leader-like traits, physical ability, intelligence, and sex-typical sexually selected traits.

What is Signaled in an Online Environment?

The proximal and evolutionary research considered above provides the basis for hypotheses on signal content in online information pools. Given that the focus here will be a Wikipedia-style environment, it is possible to discount some forms of signal content, and generate hypotheses for others.

Proximal research on contributions suggests that signaling does occur in computer-mediated environments. In the context of a computer-mediated environment, it would appear unlikely that physical ability (Smith & Bliege Bird, 2000) is signaled as making contributions to a Wikipedia page is presumably not particularly physically taxing. Similarly, signaling of sexually dimorphic traits (Barclay, 2010; Griskevicius et al., 2007) via contributions to an online information pool would also seem unlikely in many cases. Finally, while status could play a role in incentivizing signalers to engage in signaling, it could not be the content of the signal itself. Rather, status would only be an emergent property of signaling. For example, signaling intelligence or group commitment may lead to heightened status for the contributor, but status is not the information being advertised. For this reason, status is not measured as a potential piece of content being signaled in the present study.

Contributions to online information pools may signal intelligence. It is possible that contributions showcase an individual's intelligence through knowledge of otherwise

"useless" technical and arcane subject matter. Research has demonstrated that intelligence could be indicative of general fitness (e.g. Prokosch, Yeo, & Miller, 2005), and many online information pools would offer a logical platform for advertising intelligence. Furthermore, since signaling should exist only under conditions where the signal is identifiable by a receiver (Smith & Bliege Bird, 2000), it is hypothesized that:

> **H1:** Contributions to online information pools act as signals of intelligence. More intelligent contributors will contribute more and better quality contributions, but only when their contributors are identifiable to receivers.

Group commitment is another strong possibility for signal content. As reviewed, there is proximal evidence that commitment to a group or community increases the likelihood of public contributions (e.g., Flanagin et al, 2013; Nov, Naaman and Ye, 2010). Likewise, the evolutionary literature suggests that group commitment is a costly signal that is embedded in religious rituals (Sosis, 2003) and tribal scarification (Sosis, 2006). While virtual communities may not be communities in the traditional sense, the internet has provided an unprecedentedly powerful tool for the creation of *ad hoc* communities that are centered around a variety of different subcultures, hobbies, health issues and so on. Some scholars have even predicted that the internet will radically alter human social organization and the concept of community (e.g. Benkler, 2006; Shirky, 2008). It is plausible that contributions to online information pools, such as writing entries on Wikipedia, are signals of solidarity with a specific online community. Thus, if group commitment is signaled, then:

> **H2:** Contributors who identify with the community behind the creation of the online information pool will contribute more and better quality contributions but only when

the contributors are identifiable to receivers.

It is also possible that other attributes are signaled in the online environment but have not been investigated in prior research. Personality traits including introversion-extraversion and conscientiousness may be signaled. Introversion-extraversion could have various benefits. Extraverts may be better able to navigate social networks and thereby serve as useful coalition partners. More extraverted people may be more able and willing to engage with a group at large and thereby eke out more beneficial social exchange relationships than introverts. On the other hand, introverts may be more trusting or cooperative exchange partners. Similarly, conscientiousness may indicate reliability in the completion of protracted tasks that are of mutual benefit. While speculative, it is worth noting that we do not know whether online contributions contain signals nor what signal content they might constitute. The measurement of a relatively broad-set of potential signals is therefore warranted.

Finally, it is possible that signals contain multiple pieces of information and simultaneously signal all of the attributes that are considered here. Indeed, the hypothesized signal contents are not mutually exclusive. I therefore consider the following research question:

RQ: Do contributions to online information pools function as signals of intelligence, group commitment, introversion-extraversion, conscientiousness, or a combination of these traits?

Finally, since both signals and receiver's responses to signals are evolved (Maynard Smith & Harper, 1995), receivers must be able to reliably infer the signaler's levels of the trait in question:

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H3: If contributors use online information pools as platforms for signaling, then readers of these contributions can accurately infer the content of these signals. The content of these signals will be mediated by contribution quantity or judgments of contribution quality, particularly in the identifiable condition where trait(s) are most likely to be advertised.

Method

Participants and Design

This two-part study followed a one-way between subjects design with potential signal traits (i.e., IQ, group identification, introversion-extraversion, conscientiousness) as measured moderator variables. In part one, participants' general intelligence, social identification with the communication discipline, and demographic information were measured. In part two, participants were randomly assigned to one of two experimental conditions in which they were asked to contribute to a wiki-style encyclopedia on the UCSB Department of Communication. Contributions were solicited under conditions where participants would ostensibly be personally identifiable or not to readers of the article entry (i.e., incoming students). At the conclusion of part two, personality constructs, introversion-extraversion and conscientiousness were also measured. The focal dependent measures were the perceived quality of participants' contributions, as assessed by four coders blind to experimental conditions, as well as quantity of contributions, as assessed by a simple word count.

One hundred and eighteen participants were recruited from the UCSB Department of Communication undergraduate research participant pool. Participants were brought in the research lab on two occasions separated by approximately 1 week. Participants were told that the study concerned understanding the creation of crowd-sourced online encyclopedias (wikis) such as Wikipedia. Ninety eight of the original 118 participants completed both parts of the experiment (28 male; $M_{age} = 19.4$, $SD = 1.65$). Participants who completed both parts of the experiment were used in the analyses.

Materials and Procedures

Part one. General intelligence "g" was assessed using Raven's advanced progressive matrices. This test measures the "eductive ability" component of g, and factor analytic studies have repeatedly demonstrated the test to be one of the most valid measures of g available (Raven, Raven, & Court, 1998). While the full test is allotted 40 minutes, this time limit can be reduced in light of experimental constraints (see Raven, Raven, & Court, 1998). In this experiment, subjects were allotted 20 minutes, a time reduction that is expected to slightly reduce the validity of the test. However, the 20-minute version of the test is a reliable predictor (r = .74) of the 40-minute version (Hamel & Schmittmann, 2006).

Participants then completed an adapted version of Hogg and Hains' (1996) 9-item social identification measure that assessed the degree to which participants identified with the major. For example, participants were asked "how similar do you feel to those in the field of communication in terms of general attitudes and beliefs?"; "how well do you feel that you fit into the field of communication?"; and "how much do you identify with others in the field of communication?". This measure was highly reliable (α = .92).

Part two. Participants returned approximately one week later to contribute to an ostensibly real wiki-style encyclopedia being created by the Department of Communication. Subjects were told that the wiki would serve as a repository of information for incoming first-year students, and that it would contain entries related to campus life, culture, and academics. Participants were also told that the wiki was being pilot tested, and that their participation would help the researcher gain insight into the wiki creation process. By using

the campus community as the theme for the wiki, all participants had at least some knowledge that they could potentially use in creating an entry. Participants completed their entries in private laboratory rooms on a computer that displayed the wiki. The wiki resembled Wikipedia and contained a collection of preliminary articles that were created by an undergraduate research assistant prior to the experiment (see Figures 1 and 2).

Participants were told that they could contribute as little or as many entries to the wiki with as little or as much content as they would like. Participants were also told that they could contribute nothing at all. The choice of topic for a wiki entry was left entirely up to the participants. However, participants were supplied with a list of sample topics (i.e. classes, professors, a nearby place to eat, Del Playa avenue, a local bar, a campus event, a fraternity or a sorority, downtown Santa Barbara or another location of interest, an honors society or club, the school newspaper, or any other topic that is somehow related to UCSB life, culture, or academics). Participants made their contributions in a word-processing document and were told that they could use any information that they could find online (with the exception of images). The freedom of choice in article content mimics real-world Wikipedia entries, and allows for an ecologically valid test of the hypotheses. Each participant was told that they would have 30 minutes to make a contribution.

Figure 1.

The homepage of the wiki that was used in the experiment

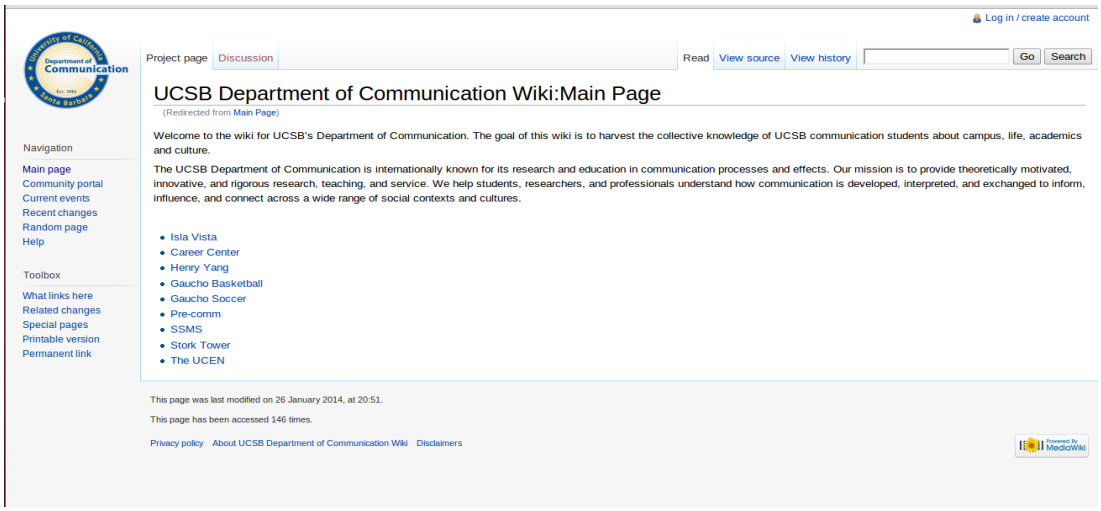
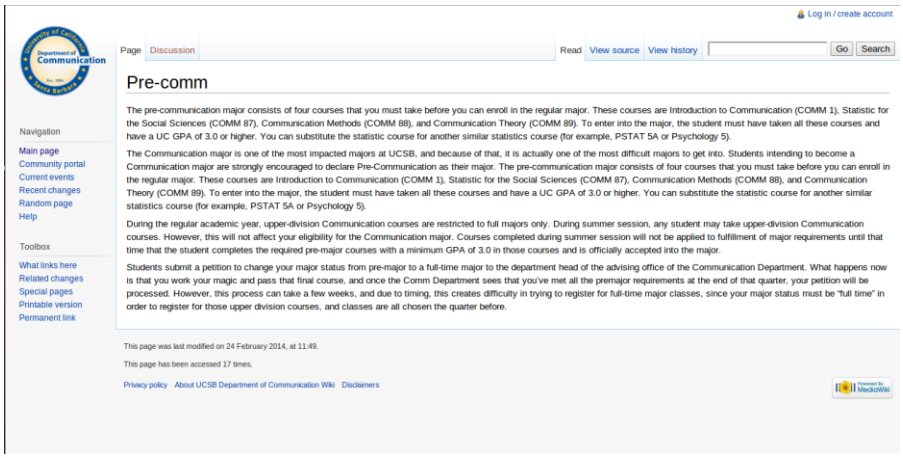
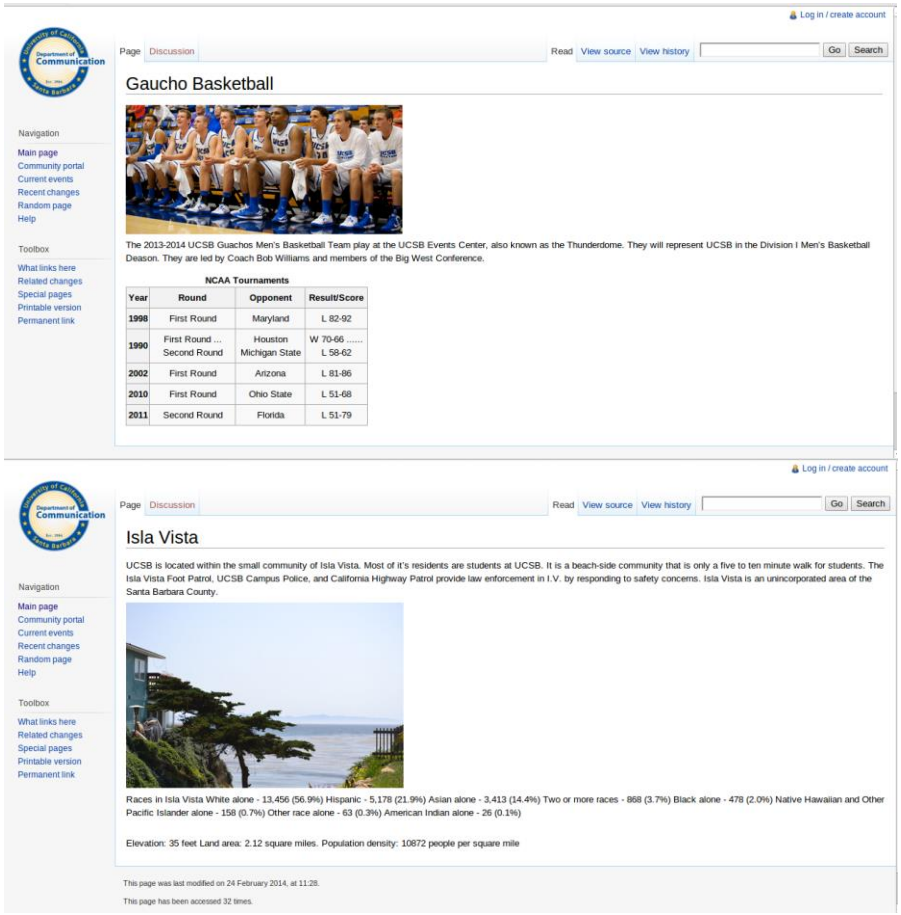


Figure 2

Sample Pages from the Wiki Used in the Experiment.





Identifiability Induction. Subjects contributing to the wiki were randomly-assigned to one of two conditions. In the identifiable condition, subjects had their photo taken and were told that the photo would be placed next to their contribution. The subjects' names also appeared in the word-processor document that contained their contribution, indicating that their identity would be linked to the contribution. In the unidentifiable condition, the subjects' photo was not taken and their name did not appear in the word-processor document.

After 30 minutes had passed, subjects completed abbreviated 12-item, 5-point Likert-type scales (1 *strongly disagree,* 5 *strongly agree*) that measured introversion-extraversion (α = .80) and conscientiousness (α = .85). These scales were taken from the NEO Five-Factor

Inventory (Costa & McCrae, 1992).

As potential covariates, participants rated "How seriously did you take the writing assignment that you just completed?" (1 *Not at all seriously*, 7 V*ery seriously)*, "How knowledgeable were you about the topic(s) you chose to write about?" (1 *Not at all knowledgeable*, 7 *Very knowledgeable*), and "How much effort did you put into the writing assignment?" (1 *Very little effort*, 7 *A lot of effort*). The completion of this questionnaire concluded the second part of the experiment.

***Dependent measures*.** The quality of the wiki contributions was rated by four undergraduate research assistants who were blind to experimental conditions. The research assistants were asked to "describe the quality" of each article on a 7-point Likert-type scale (1 *Very low quality*, 7 *Very high quality*). Finally, the research assistants judged the contributors' intelligence relative to other subjects and their level of identification with the discipline of communication, both using 7-point Likert-type scale items (1 *Much dumber than average*, 7 *Much smarter than average* and 1 *Not committed at all*, 7 *Very committed*, respectively). These questions were asked in order to ascertain whether readers of the contributions could receive these signals of unobservable traits, if participants were indeed using the wiki platform to advertise these traits.

The size of the wiki contributions was measured using the word count of the subject's wiki entry. If the subject wrote multiple wiki entries, the word count was summed across the aggregate of all the subject's wiki entries. This allows tests of quality and quantity as dependent measures of contributions.

Results

Descriptive statistics and data transformations

Subjects wrote on a variety of topics ranging from classes and local restaurants to professors and campus events. The following is an excerpt of an entry entitled *UCSB "Undie-Run"*:

> UCSB is one of many college campuses that participate in the philanthropic event known as the "Undie Run". The Undie Run occurs typically on the last Wednesday night of finals week at the end of each quarter. Participants gather at Storke Tower or the Davidson Library and remove all of their clothing until they're left in just underwear. The clothes that are removed from their bodies are donated to charity. After undressing, the students run into the streets of Isla Vista and back onto campus. The purpose of participation varies from student to student, whether they want to de-stress, rebel, have fun, and/or donate to charity.

The sample compositions for each of the two conditions were similar. Subjects in the unidentifiable condition identified slightly more with the field of communication, were slightly more extroverted, and slightly more conscientious (see Table 1 for a breakdown of descriptive statistics for each condition). A Shapiro-Wilks test revealed that the distributions of the article entry lengths as measured by word count were non-normal for the control condition, $w = .93$, $p < .01$ and the experimental condition, $w = .92$, $p < .01$. Log transformations normalized each of these distributions, leading to $w = .98$, $p = .56$ for both conditions. The average quality ratings for the control and experimental conditions were

already normally distributed, $w = .98$, $p = .44$ and $w = .99$, $p = .86$, respectively.

Intraclass correlation coefficients (ICCs) were computed (see Shrout and Fleiss, 1979) for establishing rater reliability. For article quality, the intraclass correlation using a two-way random effects model revealed moderate reliability for the average of quality ratings across all raters (ICC = .67).

Table 1

Descriptive statistics by condition

Condition	Identifiable (n = 52)		Unidentifiable (n = 46)	
	M	*SD*	*M*	*SD*
IQ score (out of 36)	20.33	4.02	20.87	3.72
Social identification	6.90	1.26	7.26	.93
Conscientiousness	3.66	.56	3.78	.59
Extraversion	3.41	.57	3.51	.47
Entry length (word count)	335.42	166.65	325.07	164.97
Entry quality	4.43	1.00	4.03	1.21

Correlations of the variables listed revealed that entry length was correlated with the perceived entry quality, $r = .53$. Both intelligence and identifiability were correlated somewhat with entry quality, $r = .22$ and $r = .20$, while conscientiousness and extraversion

had very small correlations with entry quality, $r = .10$ and $r = .10$, and entry length, $r = .12$ and $r = .17$. Thus, it seems likely that the raters used the length of an entry as a proxy for its quality. As a result, the length of the contribution was controlled for when assessing quality and vice versa in subsequent analyses.

Table 2

Correlation matrix of predictor and variables for identifiable and unidentifiable conditions

	Social identification	Intelligence	Con.	Extraversion	Entry length	Entry quality
Social identification		**-.27**	**.16**	**.15**	**.07**	**-.21**
Intelligence	-.19		**-.25**	**.02**	**-.23**	**.32***
Conscientiousness	.30*	.27		**-.16**	**.06**	**-.12**
Extraversion	.12	.10	-.05		**.05**	**.04**
Entry length	-.07	.27	.26	.31*		**.35***
Entry quality	-.06	.18	.34*	.21	.69**	

***** $p < .05$**; ****$p < .01$ ***Note:*** Correlation coefficients for participants in the identifiable condition are bolded

Tests of Focal Hypotheses

Under H1 it was predicted that quality and/or quantity of contributions to online information pools function as signals of intelligence, and that these correlations would be more apparent in the identifiable than in the unidentifiable condition.

As a first test of this hypothesis, the zero-order correlations were recalculated separately for the identifiable and unidentifiable conditions (see Table 2). In the identifiable condition, intelligence was significantly correlated with entry quality, $r = .32$, $p < .05$, but not in the unidentifiable condition, $r = .18$, $p = .22$. However, article length was not significantly correlated with entry length in the identifiable condition, $r = -.23$, $p = .09$, nor the unidentifiable condition, $r = .27$, $p = .07$.

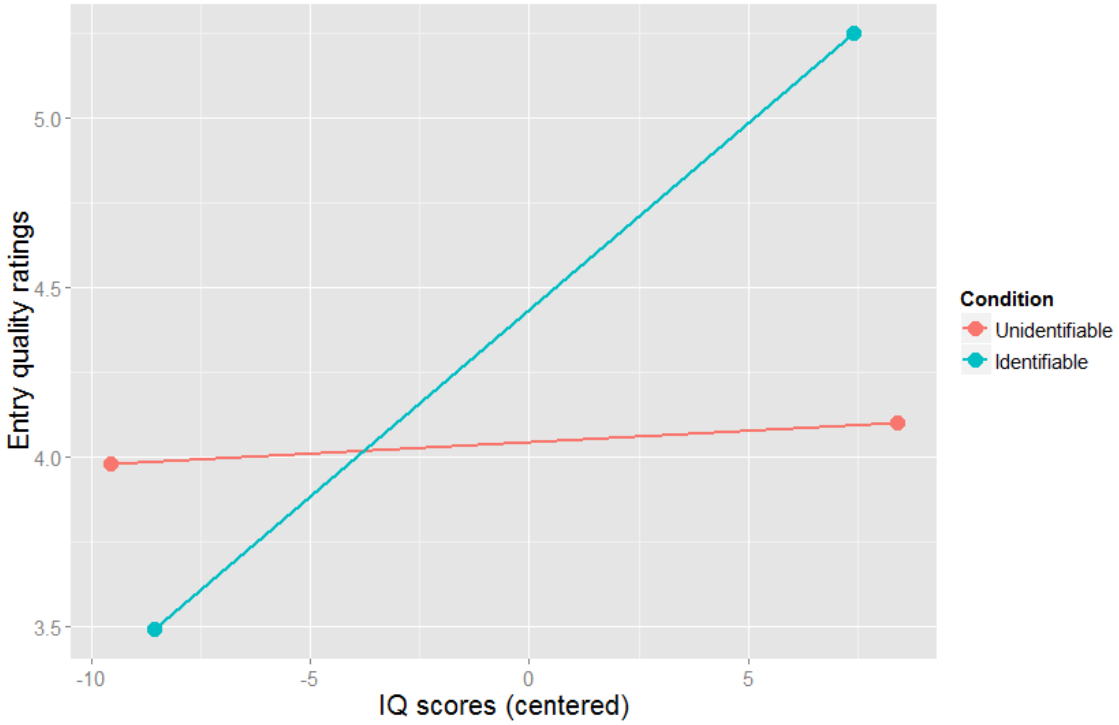
As a more stringent test of H1, regression analyses were conducted that examined the effects of intelligence on entry quality while controlling for article length (recall that these constructs were correlated $r = .53$). The experimental condition was effects coded (-1 = unidentifiable, 1 = identifiable), intelligence was mean-centered, and an interaction term calculated. A regression model showed a main effect for experimental condition, $\beta = .20$, $t(93) = 2.47$, $p < .05$, for intelligence, $\beta = .23$, $t(93) = 2.81$, $p < .01$, and an interaction, $\beta = .20$, $t(93) = 2.41$, $p < .05$.

A second model was created to test the simple slopes of intelligence on contribution quality within the two experimental conditions (see Figure 3). To test these simple slopes, the conditions were first coded to test for the effects of intelligence on entry quality for participants in the unidentifiable condition (identifiable = 1, unidentifiable = 0). In the unidentifiable condition, intelligence was not a reliable predictor of entry quality, $\beta = -.01$,

$t(93) = -1.37$, $p = .17$. To test the effect of intelligence on entry quality for participants in the identifiable condition, the conditions were reverse coded (identifiable = 0, unidentifiable = 1). In this analysis, the effect of intelligence on entry quality was statistically significant, $\beta = .44$, $t(93) = 3.98$, $p < .001$. The simple slopes model next addressed the effect of the conditions on entry quality for participants of high intelligence and low intelligence. The effect of the conditions on entry quality for participants of low intelligence was assessed by creating a similar regression model and adding one standard deviation to the intelligence variable ($\sigma = 3.87$). The effect of intelligence in this analysis was non-significant, $\beta = -.001$, $t(93) = -0.03$, $p = .97$. A similar analysis was created for participants of high intelligence by subtracting one standard deviation from the intelligence variable. The effects of identifiability for this analysis were significant, $\beta = .41$, $t(93) = -3.49$, $p = < .001$.

Figure 3

The effect of intelligence and identifiabiliy on entry quality controlling for entry length



Under H2, it was predicted that contributors use online information pools as a platform for advertising group commitment. The zero-order correlations between social identification and entry length and social identification and entry quality were non-significant in the both conditions. Thus, H2 was unsupported.

Under RQ, the question was asked whether contributions to online information pools function as signals of intelligence, group commitment, introversion-extraversion, conscientiousness, or a combination of these traits. The results of the experiment indicate that participants used the wiki only to advertise intelligence. Conscientiousness was positively associated with entry quality and extraversion was positively associated with entry length. However, this was only true in unidentifiable

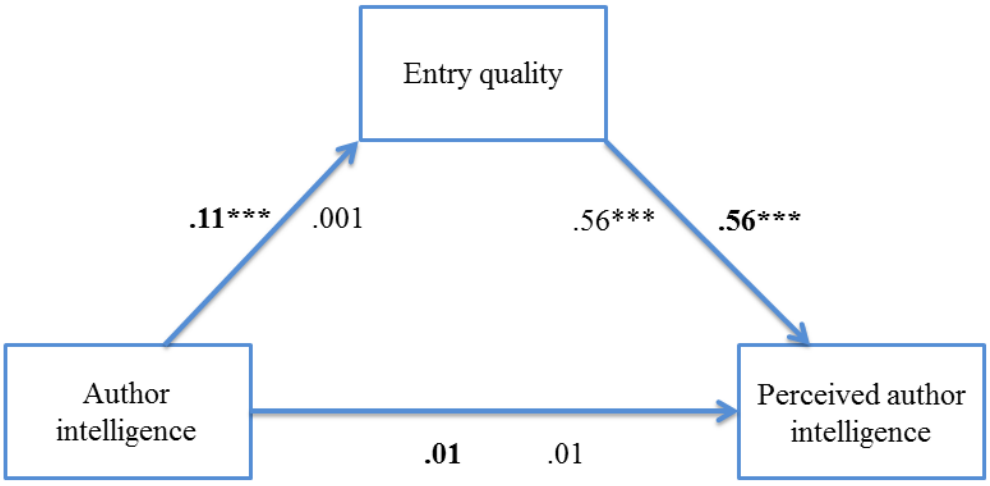
condition. Thus, no support was found for participants advertising other traits.

Under H3 it was predicted that if contributors use online information pools as platforms for signaling, then readers of these contributions can accurately infer the content of the signals, and that this ability would be more apparent in the identifiable than the unidentifiable condition. Given that there was only evidence that intelligence was signaled, the mediational hypothesis was tested for intelligence only. Thus, article quality judgments should mediate the effect of participant intelligence on judgments of intelligence, and do so most strongly in the identifiable condition.

To test H3, a regression model was created to assess whether differences in intelligence lead to corresponding differences in the authors' perceived intelligence, but only when mediated by entry quality. The experimental conditions were dummy coded, intelligence was mean centered, the interaction term included, and article length was a covariate. If H3 is correct, then the mediational model should fit more strongly in the identifiable than unidentifiable condition. (see Figure 4). The model was tested using the SPSS macro PROCESS (Hayes, 2008).

Figure 4

Full mediated regression model testing effect of author intelligence on perceived intelligence through contribution entries in identifiable and unidentifiable conditions.



Indirect mediation effects: **95% CI [.024, .103]**, 95% CI [-.018, .028]
*** $p < .001$ *Note*: Coefficients for identifiable condition in bold

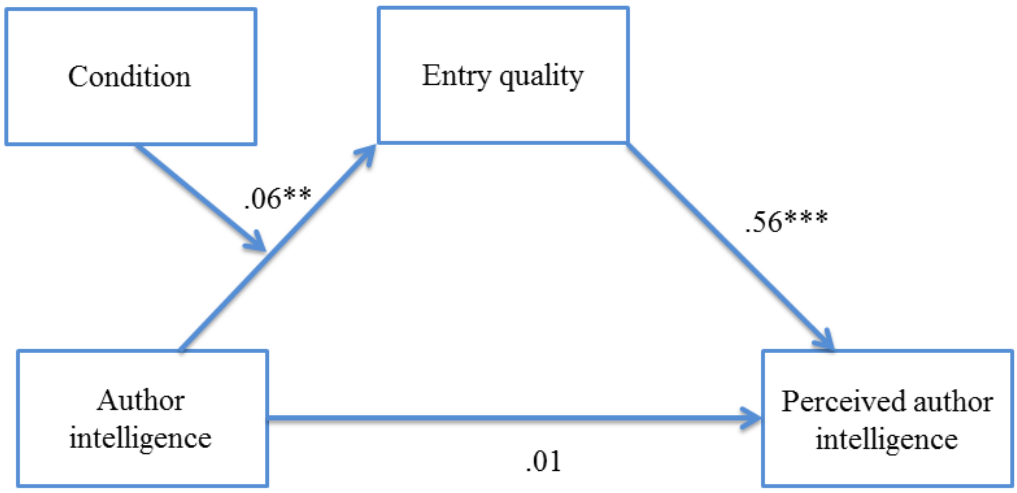
Confidence intervals for indirect effects were calculated using 5,000 bias-corrected bootstrapped samples. In the identifiable condition, author intelligence was not positively associated perceived intelligence directly, $\beta = .01$, $t(93) = .48$, $p = .63$. However, author intelligence was positively associated with entry quality, $\beta = .11$, $t(93) = 3.98$, $p < .001$, which was in turn positively associated with the perceived intelligence of the writer, $\beta = .56$, $t(95) = 12.40$, $p < .001$. The mediational model was reliable, 95% CI [.02, .10].

This model was repeated to test whether article quality judgments mediated the effect of writer intelligence on the perceived intelligence of the writer in the unidentifiable condition. As in the previous model, author intelligence did not directly predict perceived author intelligence $\beta = .01$, $t(95) = .48$, $p = .63$. Unlike the previous model, author intelligence was not associated with entry quality, $\beta = .001$, $t(93) = .21$, $p = .83$, although

entry quality still predicted judgments of author intelligence, $\beta = .56$, $t(95) = 12.40$, $p < .001$. As expected, this mediational model was not reliable, 95% CI [-.02, .03]).

Figure 5

Moderated mediated regression model testing effect of author intelligence on perceived intelligence through contribution entries.



Moderated mediation index: 95% CI [.01, .11]
**$p < .01$; *** $p < .001$

Finally, as a more stringent test, the process model tested whether condition moderated the strength of the mediated effect. In this model, intelligence served as the independent variable, entry quality as the mediating variable (after controlling for entry length), and perceived intelligence was the outcome variable (Figure 5). The condition was inserted into the model as a moderator variable between intelligence and entry quality. As in the mediation model, intelligence was a significant predictor of entry quality, $\beta = .06$, $t(93) =$

2.81, $p < .01$, which was in turn a significant predictor of perceived intelligence, $\beta = .56$, $t(95) = 12.40$, $p < .001$. The direct effect of intelligence on perceived intelligence was not reliable, $\beta = .56$, $t(95) = 12.40$, $p < .001$, 95% CI [-.02, .03]. A moderated mediation index was computed using a test of equality of the conditional indirect effects between the two conditions. The index was reliable, 95% CI [.01, .11].

Discussion

Altruistic behavior has long been a puzzle for evolutionary psychologists and biologists. Why would an organism behave in such a way that would seemingly benefit another organism without some reciprocal benefit? This puzzle has implications for public goods where individuals have a strong incentive to let others contribute while avoiding contributing themselves. Costly signaling theory provides a solution to this puzzle by interpreting altruistic behavior as a signal that provides benefits to the both the signaler and the receiver. Online information pools are public goods that suffer from the free rider problem. Nevertheless, many successful examples of these environments exist without any extrinsic reward structure. According to costly signaling theory, these environments could serve as platforms for individuals to signal some quality about themselves. We posited three potential qualities that people could be signaling in these environments: intelligence, group commitment, and personality traits.

Author intelligence was positively associated with contribution quality, but only when contributions were made under conditions where those participants would be identifiable to receivers. Further, after controlling for the length of entries, subjects of higher intelligence wrote better quality articles but only when their contributions were identifiable. There was also evidence for the hypothesis that receivers can infer signaled traits. Namely, receivers were able to infer the intelligence of contributors through judgments of the quality of their contributions, but only in the identifiable condition. There was no evidence that participants used online information pools to signal social identification, introversion-extraversion, or conscientiousness.

Signaling in Online Information Pools

The results of this experiment suggested that people contribute to online information pools as a way of signaling intelligence. Several conditions should be met for a behavior to constitute a costly signal (Smith & Bliege Bird, 2000). One condition for costly signaling to occur is that the signal must be observable to receivers. If receivers could not process the signal, then the signaler would have no incentive to engage in costly advertising. Consistent with this prerequisite to signaling, a comparison of the two conditions revealed that participants contributed better quality information when their contributions were identifiable. Further, intelligence was a predictor of better entry quality but only in the identifiable condition, suggesting as costly signaling theory predicts, that signals are generated under conditions where signalers are motivated to do so.

A second condition for costly signaling is that it must be a reliable indicator of some underlying traits possessed by the signaler. The positive relationship between entry quality and actual author intelligence suggests that more intelligent contributors make higher quality contributions. Further, the relationship between perceived author intelligence and actual author intelligence suggests that readers interpret those authors of higher quality entries as being smarter.

A third feature of costly signaling theory is that signals must be costly to produce, and the costs paid are proportional to the quality possessed by the signaler. The present study did not examine the cost of the signal, which is the mechanism for ensuring the signal's reliability. To do so, future research might examine what those costs might be.

Despite previous research which shows that group identification affects contributions in online information pools (e.g., Flanagin et al., 2013), participants who identified with the

field of communication did not contribute lengthier or better quality entries than those who did not identify with the discipline. One explanation for the lack of a relationship between social identification and the dependent variables may perhaps be attributed to the limited perceived benefits that a participant might accrue through signaling group commitment. Participants may benefit from advertising their intelligence to anybody, while signaling group commitment would only provide benefits to the signaler if the receivers of the signal also identify with the field of communication (such as other students in the department, faculty, and so on). Further, participants were told that the wiki was being created by the Department of Communication, but not that the beneficiaries of the wiki were necessarily students of communication. Thus, the beneficiaries of the wiki content might hold little interest as to whether the contributor was committed to the field of communication, which would in turn decrease the incentive for advertising such a trait. Contributors still have an incentive to advertise intelligence, however, because the beneficiary of the wiki is also is a receiver of the signal in this case. It is also possible that a wiki on a university is a more logical platform to advertise intelligence. If the wiki focused specifically on sports, for example, then intention to advertise group commitment may have played a larger role.

While this experiment has provided evidence that intelligence is signaled in the context of online contributions, further steps are necessary to provide a full test of costly signaling theory. Namely, a final condition for costly signaling is that it must offer compensating benefits to signalers and receivers. There are a number of potential reasons that people might signal intelligence. One possibility is that intelligent people make more effective coalition partners than their less intelligent counterparts. The ability to understand,

analyze, and synthesize information about the world has obvious survival benefits such as overcoming the evolutionary defenses of plants and animals (Pinker, 2010). Through advertising this highly desirable trait, intelligent people are seemingly more able to attract allies and mates. Further, other studies have linked intelligence with attractiveness (Kanazawa, 2011), body symmetry (Prokosch, Yeo, & Miller, 2005), and lower rates of certain medical abnormalities (Arden, Gottfredson, Miller, 2009). All this provides information to signal receivers that can benefit both the signaler and the receiver.

A reader might rightly point out that most contributions in an information pool such as Wikipedia are created anonymously. In the case of Wikipedia, this is the case for unregistered users. However, top contributors to the online encyclopedia have registered user names (Wikipedia: List of Wikipedians by number edits, 2014). Further, Wikipedia has stark contribution inequalities: Roughly 10 percent of registered users contribute nearly 90 percent of all information (Ortega, Gonzales-Barahona, & Robles, 2008). These elite "Wikipedians" are often active participants in offline community events such as Wikimania, an annual international conference for users of the wiki projects (Wikipedia community, 2014). Thus, while most Wikipedia editors are indeed anonymous, those doing the vast majority of the contributing do have visibility in the offline world. For example, Wikipedia's current top contributor (user name *koavf)* has a succinct biography on the site that reveals his identity. Thus, for top contributors of Wikipedia, contributions are not necessarily anonymous. A future study might examine the relationship between the intelligence of actual Wikipedia contributors and their contributions.

The current study has several limitations. First, its sample was taken from a pool of

undergraduates who are not likely representative of information pool contributors generally. For example, this sample was far more female dominated than samples taken of Wikipedians (Lam et al., 2011). Secondly, the experimental design of soliciting wiki entries bears little resemblance to the real world of creation process of Wikipedia. Thus, the study suffers from low ecological validity. These issues could be mitigated through a study that applies the theoretical framework of costly signaling theory to actual Wikipedians, though the research would sacrifice experimental control as a result. Finally, this study did not examine the potential costs that must necessarily be associated with a signal. Presumably, the cost of time committed to researching and writing an entry to an information pool such as Wikipedia woul make up at least some of the cost. Future research could assess potential costs associated with contributing. The outcome of this study results in a recommendation for systems designers and maintainers of online information pools: Information pools with higher levels of identifiability would likely lead to higher quality contributions in these environments.

Conclusion

This thesis sought to better understand why certain people behave altruistically online. Specifically, I was interested in why these people engaged in contributing to online information pools, such as Wikipedia, when they could easily free ride by benefiting from such information repositories without incurring the cost of helping create and maintain them. The study employed a theory originally from evolutionary biology that accounts for the emergence of altruism in humans. Such charitable behavior, it was argued, is a costly signal that benefits both signalers and receivers. Signalers can use this altruistic behavior to reliability advertise some underlying quality about themselves, while receivers gain information about the signaler. An experiment involving university undergraduate participants offered partial support for the hypothesis that people contribute to such online information pools to advertise intelligence. While intelligence was not associated with length of contributions to a fake wiki, it was positively associated with quality of contributions. Future research should examine questions of costly signaling in actual online information pools to see if findings are consistent with those found in the experiment conducted in this study.

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